

## **2.0 SITE CHARACTERISTICS**

Geological and hydrogeological characteristics were investigated to understand their influence on distribution and migration of contaminants at the WCP East Grand Avenue WQARF Site. Subsurface site characteristics were evaluated by reviewing the geologic literature for the area and examining lithologic samples recovered from the borings. The composition of alluvial sediments beneath the site, especially near the top of the saturated zone, is significant in assessing groundwater movement and contaminant migration at the facility. Static water levels (SWLs) measured during the investigation were used to evaluate the direction and approximate rate of groundwater movement beneath the facility. The results and evaluation of SWLs and groundwater elevation measurements obtained during the RI are presented in Section 2.7.

### **2.1 CLIMATE**

Phoenix lies at approximately 33 degrees north latitude along an arid and semi-arid zone, characterized by hot summers and mild winters. The maximum mean monthly temperature for the year is 93 degrees Fahrenheit (°F), occurring in July. Maximum and minimum temperatures in July average 106 and 81°F, respectively. The minimum mean monthly temperatures during the year occur in January at 54°F. Maximum and minimum temperatures during this month average 66 and 41°F, respectively. The yearly average temperature is approximately 73°F.

Average annual precipitation in the Phoenix area ranges from 7 to 8 inches and occurs in two distinct precipitation periods. The winter period spans December through March, with December having the highest average precipitation. These winter storms are distinguishable from summer storms by characteristically being widespread, of low intensity, and of long duration. The summer rain period usually begins in July and lasts through September, during what is classified as monsoon season. A monsoon day for the Phoenix area is any day during which the average of the hourly dew point temperatures equals or exceeds 55°F. Storms during the monsoon period are typically scattered, of short duration, of high intensity, and flash flooding

may occur. Average annual evaporation is approximately 72 inches, with the greatest evaporation occurring during the summer months (Corkhill, et al, 1993).

## **2.2 TOPOGRAPHY**

Topography in the WCP area is generally flat lying with a gentle slope to the southwest. The elevation at the northeast portion of the area is approximately 1,120 feet above mean sea level (amsl) with a gradual decline in elevation to the southwest to approximately 1,090 feet amsl. Surface elevations in the WCP East Grand Avenue WQARF Site range from approximately 1,113 feet amsl to 1,110 feet amsl.

## **2.3 SOIL**

The WCP area lies within the West Salt River Valley (SRV) of the Basin and Range physiographic province. The area is located within a larger area of Quaternary sedimentary deposits composed mainly of alluvial gravel, sand, silt, and clay in flood plains, terraces, fans and former lakebeds. The area is characterized by deep, well-drained soils formed in recent alluvium. The soils are derived from a mixture of rock, including schist, granite, andesite, and rhyolite. The majority of surface soils consist of brown clay loams and loamy fine sand having moderate to moderately low permeability.

## **2.4 REGIONAL GEOLOGY**

The SRV is an alluvial basin consisting of a thick sequence of basin-fill deposits of unconsolidated to semi-consolidated clastic sediments of Late Tertiary to Quaternary age (Corkhill et al., 1993). The basin-fill deposits range in thickness from less than 100 feet near the margins of the basin to over 10,000 feet in the central areas of the basin (Corkhill et al., 1993). The basin-fill deposits consist of interbedded sequences of conglomerate, gravel, sand, silt, clay, and evaporites. These deposits comprise the regional aquifer in the SRV and have been divided into hydrogeologic units, as discussed in later sections.

The SRV is surrounded by generally northwest-southeast trending, fault-blocked mountain ranges characteristic of the Basin & Range physiographic province. The rocks that comprise the

floor of the SRV and surrounding mountain ranges predominantly consist of Precambrian to middle Tertiary crystalline and middle Tertiary to Quaternary extrusive rocks (Brown and Pool, 1989). The crystalline rocks are composed of metamorphic and granitic rocks including schist, gneiss, metavolcanics, quartzite, and granite. The extrusive rocks include rhyolites and basalts. These crystalline units may transmit small quantities of water where they are fractured, but are not considered a regional scale aquifer (Corkhill et al., 1993).

The red unit, also known as the Tempe beds and the Camel's Head Formation, is a sedimentary rock of Late Tertiary age. This unit consists of reddish-colored, well-cemented breccia, conglomerate, sandstone, and siltstone and locally forms the bedrock in the valley (Laney and Hahn, 1986). The breccia and conglomerate are poorly sorted and particle size ranges from clay to boulders. The upper portion of the red unit contains interbedded volcanic flows and pyroclastic rocks. The red unit is not a significant source of groundwater on a regional scale due to its limited areal extent and cementation (Corkhill et al., 1993).

## **2.5 SITE GEOLOGY**

Subsurface lithology was determined by analyzing lithologic samples collected from soil borings and monitor wells drilled at the facility and surrounding area during current and previous investigations. Soil borings were completed to varying depths ranging from 121 to 182 feet bgs on the VW&R facility property. The groundwater monitor wells were completed to varying depths ranging from 125 to 245 feet bgs. None of the borings or monitor wells drilled during the investigation encountered bedrock.

Based on lithologic samples, subsurface sediments beneath the facility are predominantly fine sandy silts to silty sands with varying amounts of clays and gravels inter-bedded throughout. Highly dense calcified zones were also encountered during the investigation at varying depths ranging from approximately 60 to 90 feet bgs. Up to three zones of gravelly sand (up to 40 percent gravel) have been documented in borings at the facility. Lithologic descriptions of sediments encountered during the investigation are presented in the lithologic logs found in Appendix A.

Stratigraphic units encountered during the subsurface investigations at the VW&R facility and in the WCP East Grand Avenue WQARF Site have been identified, correlated, and illustrated on cross sections and maps (Figures 2-1 through 2-8). The cross sections have been prepared to include stratigraphic units with Unified Soil Classification System (USCS) symbols, interpretation/correlation of these units, approximate groundwater elevations as of January 2002, significant stratigraphic features, and borings/monitor wells used to construct the cross sections.

## **2.6 REGIONAL HYDROGEOLOGY**

The SRV consists of two distinct but interconnected alluvial groundwater basins, the West SRV and the East SRV. The WCP East Grand Avenue WQARF Site lies within the West SRV. A lower unit consisting of mostly conglomerate and gravel, a middle unit of predominantly silt and clay, and an upper unit of mostly sand and gravel generally characterize the basin-fill deposits of the valleys. Corkhill et al. (1993) present a correlation of the units as defined by the U.S. Bureau of Reclamation (USBR), Arizona Department of Water Resources (ADWR), and the U.S. Geological Survey (USGS). This RI report uses the hydrogeologic units as defined by ADWR, which are based on particle size, lithologic data, and the unique hydraulic properties of the units (Corkhill et al., 1993). The three hydrogeologic units are, in descending stratigraphic order:

- Upper Alluvial Unit (UAU)
- Middle Alluvial Unit (MAU)
- Lower Alluvial Unit (LAU)

The UAU consists of gravels, sands, and silts deposited during the final stages of development of the alluvial basin. Near the riverbeds of the Salt and Gila Rivers and along the margins of the basins, the UAU is predominantly gravel and sand, whereas in other areas the unit is typically sand and silt. The relatively uniform thickness of the unit and association of coarser-grained sediments with the locations of major drainage suggest that the unit was deposited by the ancestral Salt River after the establishment of through-flowing drainages and from alluvial fans along the mountain fronts. The UAU is reported to be between 300 and 400 feet thick in the West SRV (Corkhill et al., 1993). The UAU was once the primary source of groundwater for the

West SRV; however, the unit has been dewatered in many areas due to groundwater withdrawal. Groundwater is typically unconfined; however, semi-confined conditions exist locally where there is an increase in finer-grained materials (USBR, 1977). Hydraulic conductivity values for the UAU reported by Corkhill et al. (1993) are 20 to 250 feet per day (ft/day) and are highest near the Salt and Gila Rivers. Additionally, potential yield to wells completed in this unit were reported to range from 1,500 to 5,500 gallons per minute (gpm).

The MAU is generally considered an aquitard, but does yield water from interbedded, coarser deposits and sandy horizons (USBR, 1977). The MAU consists of clay, silt, mudstone, and gypsiferous mudstone with some interbedded sand and gravel. The unit is estimated to be approximately 650 feet thick in the West SRV with the top of the unit at 300 to 400 feet bgs. Corkhill et al. (1993) state that the MAU is the primary source of groundwater in the SRV and speculated that the recoverable groundwater in the unit originated from interbedded coarse layers. Hydraulic conductivity values reported for the MAU range from 5 to 50 ft/day and potential yield for wells screened in the unit range from 350 to 2,200 gpm.

The LAU overlies, or is in fault contact with, the crystalline rock unit and the red unit. The LAU is composed predominantly of conglomerate and gravel deposits near the basin margins, grading to mudstone, gypsiferous and anhydritic mudstone and anhydrite beds in the central portions of the basins. The thickness of the LAU near the basin margins is less than 100 feet, but the thickness of the unit is unknown in the central portions of the basin due to the lack of deep drilling data. Wells tapping the LAU are typically located around the periphery of the valley. Hydraulic conductivity values for the LAU range from 5 to 60 ft/day and potential well yields range from 50 to 3,500 gpm. Corkhill et al. (1993) state that most of the recoverable groundwater from this unit is from the upper 500 feet. The LAU is estimated to be encountered around 1,000 feet bgs in the West SRV and may be up to 1,600 feet thick.

The regional groundwater flow in the West SRV is greatly influenced by groundwater pumping. Historical water level elevation contour maps developed from data from 1913 show a west to southwest flow direction having a gradient of approximately 0.002 feet/foot (ft/ft) (USBR, 1977).

Major sources of recharge in the SRV are from infiltration in the Salt River, seepage losses from irrigation canals, and excess irrigation. Within the WCP area, the Grand Canal, an irrigation canal that transports water across the SRV, was a major source of artificial recharge to the UAU. In recent years, many areas of the Grand Canal have been lined reducing its influence on recharge of the UAU. The source of water in the canal is from surface water from the Salt and Verde Rivers and from groundwater pumped by the SRP.

## **2.7 SITE HYDROGEOLOGY**

The stratigraphy beneath the WCP East Grand Avenue WQARF Site is consistent with its regional geologic setting generally consisting of heterogeneous alluvial/fluvial valley-fill deposits. The primary aquifer of concern beneath the VW&R facility and the WCP East Grand Avenue WQARF Site is the UAU. Lithologies in the upper portion of the saturated zone beneath the facility are typically fine-grained, consisting predominantly of sandy silts with silty sands. A coarser-grained zone of varying thickness was encountered in WCP-30, WCP-40, WCP-41, WCP-43, WCP-45, WCP-46, WCP-47, and WCP-48 at a depth ranging from approximately 134 to 145 feet bgs. In general, however, the formation is dominated by fine sediments at this depth, with variable clay and sand content.

Geophysical logs obtained during the installation of WCP-48 indicated sand layers from approximately 110 to 115 feet bgs, 132 to 148 feet bgs, 155 to 165 feet bgs, and 220 to 240 feet bgs. The results of geophysical logging at WCP-48 are presented in Appendix B.

Inflow to the UAU in the WCP East Grand Avenue WQARF Site is primarily from infiltration from the Grand Canal and from groundwater flow into the area. According to a map showing lined and unlined portions of the canal provided by the Salt River Valley Water User's Association, there are three reaches of the canal in the immediate vicinity of the WCP East Grand Avenue WQARF Site that are lined, unlined, or lined on one side of the canal only. The dates when the canal was lined are not documented. A 1995 Water Transmission System report from SRP shows the entire reach of the canal within the WCP East Grand Avenue WQARF Site

as being lined on the south bank. Information from SRP in 2000 indicated that some reaches are lined on the bottom as well.

A visual inspection of the Grand Canal between 19<sup>th</sup> and 39<sup>th</sup> Avenues was conducted on January 24, 2002. This inspection was conducted during the annual canal dry-up that occurred January 4, through February 3, 2002. Based on observations made during the inspection, the canal is primarily unlined between 19<sup>th</sup> Avenue and Interstate 17 except for lined portions near Indian School Road, 23<sup>rd</sup> Avenue, and Interstate 17. The canal is lined on the south bank and on the southern half of the bottom from Interstate 17 to 27<sup>th</sup> Avenue and on the bottom and both banks from 27<sup>th</sup> Avenue to 39<sup>th</sup> Avenue. Data from the SRP showed that lined portions of the canal still contribute water to the groundwater system. There is minimal recharge from irrigation of landscaping or infiltration of precipitation.

### **2.7.1 Groundwater Gradients and Flow Directions**

WESTON has been collecting depth-to-groundwater measurements from approximately 40 monitor wells located throughout the WCP East Grand Avenue WQARF Site and its vicinity. Depth-to-groundwater data collected during the monitoring events were used to calculate groundwater elevations in feet amsl (COP datum) and estimate groundwater flow directions and gradient in the WCP East Grand Avenue WQARF Site. WESTON also conducted an aquifer test at groundwater monitoring wells WCP-28 and WCP-29 and constructed a groundwater flow model for the WCP East Grand Avenue WQARF Site vicinity.

Groundwater elevations were entered into a database and then plotted and contoured using SURFER<sup>®</sup>, a commercial contouring software package. Groundwater elevation contour maps for April 1999 and May 1999 (Figures 2-9 and 2-10) and the quarterly groundwater elevation contour maps for September 1999 through January 2002 (Figure 2-11 through 2-20) are included. The quarterly groundwater elevation data were collected to correspond with

groundwater sampling event dates. The groundwater elevation contour maps include depth-to-groundwater measurements and groundwater elevations.<sup>1</sup>

Groundwater elevations measured during January 2002 ranged from 1,004 feet amsl near the intersection of Weldon Avenue and 27<sup>th</sup> Avenue to 978 feet amsl near the intersection of 33<sup>rd</sup> Avenue and Earll Drive (Figure 2-20). Water levels appear to fluctuate approximately 5 feet per year, due to regional changes in groundwater elevations. Hydraulic gradients vary from 0.025 ft/ft northeast of the site north of the Grand Canal to approximately 0.002 ft/ft at the southwestern portion of the site due to changes in hydraulic conductivity.

WESTON contacted municipal facilities, ADWR, and private consulting companies to obtain pumping data for irrigation and/or remediation wells operated in the WCP East Grand Avenue WQARF Site. The pumping data were evaluated with the groundwater elevations to determine the effect pumping has on the groundwater flow directions and gradient beneath the WCP East Grand Avenue WQARF Site.

WESTON contacted the SRP to obtain pumping data for the irrigation wells 10.5E-7.5N and 11.2E-7.7N located to the west and east of the VW&R facility, respectively (Figure 2-1). SRP operated these irrigation wells during the month of April 1999, removing approximately 161 ac-ft of groundwater from irrigation well 10.5E-7.5N and 96 ac-ft of groundwater from irrigation well 11.2E-7.7N. ADEQ finalized an agreement with SRP in April 1999 to temporarily discontinue operation of both irrigation wells.

Depth-to-groundwater data collected in April 1999 indicated that groundwater flow and gradient are influenced by the operation of the SRP irrigation wells. Groundwater flow directions during the April 1999 monitoring event, when SRP was pumping from 10.5E-7.5N, were toward the west-northwest beneath the WCP East Grand Avenue WQARF Site. Groundwater elevation data

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<sup>1</sup> Groundwater elevation data for MGL-3, located on the Mogul facility, is anomalous and is not used for contouring. Depth-to-water groundwater measurements taken at MGL-3 are consistently two feet deeper than nearby wells. The limited data available to WESTON provide no explanation for the anomaly. Two possible causes are construction problems with the well or an error in the surveyed top-of-casing elevation.

for the remaining monthly monitoring events indicate that groundwater generally flows toward the west-southwest beneath the WCP East Grand Avenue WQARF Site.

### **2.7.2 Groundwater Elevation Hydrographs**

WESTON prepared hydrographs summarizing changes in groundwater elevations over time for all wells included in the monitor well network (Figures 2-21 through 2-24). Groundwater data collection for this project began in April 1999 and continued monthly through the January 2002 monitoring period. Data from earlier studies are included on the hydrographs.

WESTON evaluated changes in groundwater elevations over time beneath the WCP East Grand Avenue WQARF Site by grouping wells that have similar geographic locations and similar hydrogeologic settings together. The hydrographs all show a seasonal fluctuation in water levels that is caused by seasonal variations in groundwater extraction and potentially by the reduction in recharge during the annual dry up of the Grand Canal during December or January. Groundwater elevations are highest during early spring and decline to their lowest elevations during November and December.

The hydrographs also show a downward trend in elevations for water levels collected during the same month each year. Groundwater elevations in WCP-15 and WCP-16 have declined approximately 17 feet since 1997 and approximately 4 to 6 feet throughout the remaining WCP East Grand Avenue WQARF Site area since 1999. These declines are the result of regional declines in water levels, as groundwater pumping in other areas of the SRV has increased to meet irrigation needs due to decreases in surface water supplies because of drought conditions in the watershed.

The direction of groundwater flow is generally towards the southwest across the site and appears to be strongly influenced by the episodic pumping of SRP well 10.5E-7.5N, located less than 2,000 feet west of the VW&R facility (WESTON, 1997). This well, drilled in 1949, is screened from 210 feet bgs to 685 feet bgs. Pumping records obtained from SRP indicate that this well was last pumped in April 1999, removing 161 acre-feet (ac-ft) of groundwater. Between 1972 and 1999, annual pumping rates for the well ranged from 0 to 3,581 ac-ft, averaging 965 ac-ft per

year. Available data indicate that groundwater flow directions beneath the WCP East Grand Avenue WQARF Site shift from a southwesterly flow direction to a westerly or northwesterly direction when the SRP well is pumping (Figure 2-9) (WESTON, 1997). Fluctuations in the groundwater flow direction caused by pumping of the SRP well may have caused broadening of the downgradient contaminant plume and accelerated contaminant migration.

A second SRP well (11.2E-7.7N), is located along the south side of the Grand Canal, east of the VW&R facility near the southbound frontage road of Interstate 17. This well was drilled in 1950 and was screened from 200 to 485 feet bgs. The impact of pumping in 11.2E-7.7N on groundwater and the contaminant plume is less clear than the impact of 10.5E-7.5N. The well pumped an average of 386 ac-ft per year between 1972 and 1999, with a range in annual pumping of 0 to 1,334 ac-ft per year. In April 1999, 96 ac-ft of groundwater were removed from the well. ADEQ finalized an agreement with SRP in April 1999 to temporarily discontinue operation of both 11.2E-7.7N and 10.5E-7.5N.

Other pumping wells near the VW&R facility include the Michigan Trailer Park well, owned by Michigan Mobile Home Park LLC, and a well owned by Danone Waters of North American (Danone). The Michigan Trailer Park well, located approximately 2,000 feet west of the facility, is approximately 400 to 600 feet deep. This well was constructed prior to 1946 and there are no records available indicating the screened interval of the well. The pumping capacity of the well is approximately 80 gpm (Pederson, 2001). The Danone well, located approximately 3,000 feet to the southwest of the facility, is 952 feet deep with a screened interval of 850 to 950 feet bgs and a pumping capacity of 225 gpm (Jackson, 2001). Pumping from either well does not appear to impact the groundwater elevation in the WCP East Grand Avenue WQARF Site.

### **2.7.3 Aquifer Testing**

WESTON conducted an aquifer test at groundwater monitoring wells WCP-28 and WCP-29 (Figure 2-1). The results of the May 22 through 23, 2001 test are summarized below. The complete Aquifer Test Report is presented as Appendix C.

### **2.7.3.1 Step Drawdown Test**

Step drawdown testing was conducted on the selected wells to identify a sustainable pumping rate that would stress the aquifer. Wells WCP-28 and WCP-29 selected for aquifer testing were redeveloped via bailing, surging, and pumping prior to testing to ensure that development effects would not significantly impair interpretation of testing results.

WESTON conducted step drawdown tests at WCP-28 and WCP-29 on May 10, 2001. A Hermit™ 3000 data logger with an In Situ PXD-261™ pressure transducer was installed in the pumping well to monitor changes in groundwater levels. A flowmeter accurate to  $\pm 0.1$  percent gpm was used to monitor and record discharge rates and total flow. A water-level indicator accurate to 0.01 feet was used to manually confirm transducer data in the pumped well and to monitor water levels in the observation well. The step tests consisted of three steps for WCP-28 and four steps for WCP-29 of approximately one-hour duration each (Table 2-1 of Appendix C). Each well was pumped at a constant discharge rate until drawdown stabilized. Data were plotted as they were collected.

### **2.7.3.2 Aquifer Test and Recovery**

Groundwater monitor well WCP-29 was pumped at 34.7 gpm for approximately 21.5 hours (approximately 45,000 gallons) using a Flint and Walling® 2-horsepower submersible pump. The pump was suspended approximately 1 foot from the bottom of the well. Drawdown was monitored using a Hermit™ 3000 datalogger attached to pressure transducers in groundwater monitor wells WCP-29, WCP-28, and WCP-16. Solinst® PXD-261 Leveloggers® were installed in observation wells WCP-15 and WCP-84, and background wells WCP-17 and WCP-42. Additionally, a Barologger™ was suspended in WCP-84 to monitor changes in barometric pressure. Once the pumping phase of the aquifer test was completed, recovery data were collected in the pumping, observation, and background wells for the next 300 minutes (Figure 1-3 of Appendix C). A water-level indicator was also used to manually measure depth-to-water during the pumping and recovery stages of the test in addition to the pressure transducers. This provided independent confirmation of data obtained from the pressure transducers. Data were

plotted as they were collected. The aquifer test was suspended after 21.5 hours because IDW storage tanks neared capacity and the data were sufficient to analyze for aquifer parameters.

The total drawdown for each well at the end of the pumping portion of the test was WCP-29 at 2.95 feet, WCP-28 at 1.24 feet, WCP-16 at 1.21 feet, WCP-15 at 0.51 feet, and WCP-84 at 0.63 feet. Background wells WCP-17 and WCP-42 did not respond to the pumping event. The drawdown data are presented in the Aquifer Test Report (Appendix C). The time-drawdown data collected during the pumping and recovery portions of the aquifer test are illustrated in Figures 4-1 through 4-5 of Appendix C.

Analysis of data was accomplished using the Theis Unconfined Method (Theis, 1935), Theis Recovery Method (Theis, 1935), and the Cooper Jacob Approximation to the Theis Equation (Cooper and Jacob, 1946). Prior to data analysis, groundwater levels were corrected for outside influences such as barometric pressure changes and regional groundwater level changes. The corrected aquifer test data were imported into AquiferWin32™ (Environmental Solutions, Inc., 1999) for analysis and analyzed using the late time data, believed to be more representative of aquifer conditions (Kruseman & de Ridder, 1990). However, the early data from the recovery portion of the aquifer test were used during the Theis Recovery analysis. The analytical results are summarized in the following table.

<b>Transmissivity (gallons/day/foot)</b>			
<b>WELL ID</b>	<b>Theis Unconfined</b>	<b>Theis Recovery</b>	<b>Cooper and Jacob</b>
WCP-15	31,532	29,906	26,141
WCP-16	28,987	29,331	27,952
WCP-28	29,219	27,906	28,060
WCP-29	na	28,764	na
WCP-84	35,702	30,466	26,550

na = not analyzed

<b>Hydraulic Conductivity (gallons/day/foot squared)</b>			
<b>WELL ID</b>	<b>Theis Unconfined</b>	<b>Theis Recovery</b>	<b>Cooper and Jacob</b>
WCP-15	1,704	1,617	1,413
WCP-16	1,567	1,585	1,511
WCP-28	1,579	1,508	1,517
WCP-29	na	1,555	na
WCP-84	1,930	1,647	1,435

na = not analyzed

Note: Hydraulic conductivity was calculated using an approximate aquifer thickness of 18.5 feet in the aquifer test area.

An analysis of data collected from the four observation wells suggests that transmissivity ranges from 26,141 to 35,702 gallons per day per foot (gal/day/ft) [3,495 to 4,773 square feet per day (ft<sup>2</sup>/day)] (Figures 4-6 to 4-15 of the Aquifer Test Report in Appendix C). Data collected from WCP-29 during the aquifer test indicated a transmissivity of 28,764 gal/day/ft (3845 ft<sup>2</sup>/day) (Figure 4-10 of Aquifer Test Report in Appendix C). Hydraulic conductivity in the pumping and observation wells ranged from 1,413 to 1,930 gallons per day per square feet (gal/day/ft<sup>2</sup>) [189 to 258 feet per day (ft/day)]. The short duration of the aquifer test resulted in low storage coefficients ranging from 8.3 E-04 to 3.3 E-03.

### 2.7.3.3 Velocity Calculation

The average linear velocity of groundwater can be estimated using the following equation (Bear, 1979):

$$V = K/n_e \quad (dh/dl)$$

V = average linear velocity (ft/day)

K = hydraulic conductivity (ft/day)

n<sub>e</sub> = effective porosity

dh/dl = hydraulic gradient

The following ranges of hydraulic parameters were used:

Hydraulic Conductivity, K (ft/day)	189 – 258
Effective Porosity, $n_e$	0.20 – 0.30
Hydraulic Gradient, dh/dl	0.00381 – 0.00667

The equation was used in combination with the range of hydraulic parameters given above to calculate a range of average linear groundwater velocities. Based upon the hydraulic parameters at the WCP East Grand Avenue WQARF Site aquifer test, the average linear velocity of groundwater is 2.4 to 8.6 ft/day.

## 2.8 WATER QUALITY

The WCP East Grand Avenue WQARF Site is located in the western portion of the SRV. Groundwater quality throughout the area is the result of naturally occurring geochemical processes and human activities (Brown and Pool, 1989). Groundwater in alluvial basins undergo geochemical changes due to natural factors such as mineralogy, the presence of evaporite deposits, and the order in which various mineral assemblages are encountered during groundwater movement (Freeze and Cherry, 1979). Human influences such as sewage effluent, stormwater runoff, and recharge of excess irrigation have affected groundwater quality in portions of the western SRV. Generally, groundwater within the western portion of the SRV is acceptable for domestic, agricultural, and industrial uses. However, concentrations of fluoride, nitrate, or dissolved solids exceed drinking water standards at certain locations within the SRV (Reeter and Remick, 1986). The principal ions present within local groundwater include sodium, calcium, chloride, and bicarbonate (Reeter and Remick, 1986).

## 2.9 POTENTIAL IMPACTS TO WATER QUALITY

WESTON evaluated other facilities that may have contributed to the degraded groundwater quality within the WCP East Grand Avenue WQARF Site. A review of the ADEQ leaking underground storage tank (LUST) database was conducted to identify sites within an approximate 0.5-mile radius of the VW&R facility. LUST facilities were reviewed because of

the potential for petroleum hydrocarbon contamination to facilitate natural biodegradation of VOCs.

The ADEQ database indicated several facilities near the WCP East Grand Avenue WQARF Site boundary that had a release from an underground storage tank (UST) system (Table 2-1). Figure 2-25 shows the locations and approximate property boundaries of those facilities. Facility names in both Table 2-1 and Figure 2-25 are as they appear in the ADEQ LUST database and do not necessarily reflect facilities currently located on the property. The following facilities have been identified as having the greatest potential impact to water quality in the WCP East Grand Avenue WQARF Site.

### **2.9.1 Southwest Roofing and United Parcel Services Facilities**

The Southwest Roofing/United Parcel Services (UPS) property is located approximately 1,700 feet southwest of the VW&R facility at 3151 West Osborn Road (Figure 2-25). Both facilities are listed in the ADEQ LUST database as having releases from USTs. The Southwest Roofing facility was located in the northwestern portion of the property that is now owned by UPS.

LUST File Numbers 1034.01 through 1034.03 are assigned to releases at the UPS facility. The current LUST site status for all three LUST file numbers associated with the UPS facility is "5R1", which indicates the files are closed and soils meet the Risk-Based Corrective Action (RBCA) Tier 1 requirements (ADEQ, 2001). Eight USTs have been closed and removed from the property, which included four gasoline USTs, two bulk-oil USTs, and two used-oil USTs (Blasland, Bouck, and Lee [BBL], 1997). Assessment of the impacted soils related to the releases was completed and a soil vapor extraction (SVE) system was operated on the property from April 1991 through April 1992.

PCE was detected in a soil sample collected during a 1996 site characterization of the property. The sample had a PCE concentration of 220 micrograms per kilogram ( $\mu\text{g}/\text{kg}$ ) and was collected at a depth of 9 to 11 feet bgs. The concentration of PCE detected in soils at the UPS facility was below the minimum Groundwater Protection Level (GPL) of 1,300  $\mu\text{g}/\text{kg}$ . BBL (1997) concluded that the presence of PCE was attributed to the WCP East Grand Avenue WQARF Site

groundwater plume. Because PCE was detected close to the ground surface, with no detections of VOCs deeper within the soil profile, it is unlikely that the detection of PCE could have been attributable to the underlying groundwater plume.

LUST File No. 2593.01 is assigned to the Southwest Roofing facility. A release was reported following the removal of one 1,000-gallon gasoline UST in December 1992. The current LUST site status of the Southwest Roofing facility is "1D", which indicates that the extent of contamination in soil and groundwater has been defined and remediation is required. An SVE/air sparging remediation system was installed by AMEC and became operational in January 2001.

Southwest Roofing monitor wells MWB-4, MWB-5, and MWB-6 were included in the WCP East Grand Avenue WQARF Site groundwater-sampling network. MWB-14 was added to the sampling network during Round 13. Groundwater elevation data indicate the presence of a groundwater mound at the Southwest Roofing and UPS properties that may result in changes to groundwater flow beneath the property. The mound appeared concurrently with the start of air sparging activities in January 2001 and is believed to be a result of those activities. The potential effects of the remediation system to groundwater flow in the area should be evaluated further during remedy selection for the WCP East Grand Avenue WQARF Site. The remediation system treats groundwater *in situ* and does not require pumping of groundwater.

## **2.9.2 Former Fedmart/Sunbelt Facility**

The former Fedmart/Sunbelt property is currently part of the Shamrock Towing property, located near the intersection of Osborn Road and Grand Avenue, approximately 950 feet to the southwest of the VW&R facility (Figure 2-25). Fedmart/Sunbelt operated a retail gasoline distribution facility from 1967 to 1990. In 1990, the facility was closed and the property was sold. Three 10,000-gallon gasoline USTs were excavated and removed from the property at that time.

Two historical releases were identified on the former Fedmart/Sunbelt property. LUST File No. 1618.01 was assigned to a release within the UST basin, and LUST File No. 1618.02 was

assigned to a release in the former dispenser island area. One groundwater/SVE well was installed in November 1991 within the UST basin area. Approximately 1.2 feet thick of free product accumulated in this well shortly after installation (EnecoTech, 1999).

EnecoTech Southwest, Inc. (EnecoTech) conducted a site characterization of the property in 1999. Five soil borings were drilled and sampled and four groundwater monitor wells were installed on the property. To date, a total of eight groundwater wells have been installed on the property (EnecoTech, 2002). Free product was again observed in two of the groundwater monitor wells at a thickness of 0.30 and 0.70 feet.

Approximately 80 gallons of product were bailed from wells on the site in 2002 (EnecoTech, 2002). The LUST files associated with the Fedmart/Sunbelt property remain open; however, no remediation systems are currently in place at the property.

The groundwater monitor well MW-2 (ENT-MW-2) was added to the WCP East Grand Avenue WQARF Site groundwater sampling network in March 2000. Concentrations of benzene, toluene, ethylbenzene, and xylenes (BTEX) detected in ENT-MW-2 since March 2000 are as follows:

- Benzene, 3,500 to 7,000 µg/L
- Toluene, 1,500 to 6,100 µg/L
- Ethylbenzene, 850 to 1,400 µg/L
- Total xylenes, 1,600 to 7,600 µg/L

Detection limits for PCE, TCE, and 1,1-DCE in samples collected from ENT-MW-2 were typically elevated to 25 µg/L or 50 µg/L because the high BTEX concentrations required dilution of the samples prior to laboratory analyses. When detection limits for these chlorinated VOCs were lower (0.05 µg/L), the detected concentration of PCE, TCE, and 1,1-DCE was 2 µg/L or less.

### **2.9.3 Levitz Furniture Store**

Levitz Furniture (Levitz) is located north of the VW&R facility at 2801 W. Indian School Road (Figure 2-25). From 1967 through 1987, a UST located on the southeast corner of the property was used to store gasoline. The UST was abandoned in-place in 1987 by pouring slurry into the tank and then covering the area with asphalt (Earth Tech, 1995).

In March 1994, Coronado Engineering and Consulting (CEC) conducted a Phase I Site Assessment for Levitz. Contaminant concentrations above the suggested soil clean up levels were detected in samples retrieved from boreholes drilled near the UST area. The release was reported to ADEQ and assigned LUST File Number 3490.01.

Earth Tech installed groundwater monitoring wells and an SVE system on the property in 1995. Free product has been consistently noted in two on-site wells, and as of September 24, 2001, 279.75 quarts of free product have been recovered at the facility (AMEC, 2001). The most recent analytical data available, July 2001, indicate BTEX concentrations in groundwater remain in exceedance of their respective AWQS/MCLs. Additional compounds have been detected in groundwater including 1,2-dichloroethane (1,2-DCA), methyl tert-butyl ether (MTBE), and 1,2-dibromoethane. All three of these compounds have been used as gasoline additives. These contaminants do not appear in upgradient wells on the WCP East Grand Avenue WQARF Site and are present only in wells associated with other LUST sites downgradient from the VW&R facility.

### **2.9.4 ARCO Service Station**

The former ARCO Service Station facility #5275 is located south of the VW&R facility at 2926 NW Grand Avenue (Figure 2-25). This facility was evaluated to investigate potential contribution to the high benzene concentrations detected in WCP-202. A UST release of unknown volume was reported to ADEQ in November 1993 and LUST number 3198.01 was assigned to the release.

A Final Site Characterization Report for the facility was prepared in 1996, which reported that concentrations of BTEX in soil samples recovered from borings drilled on the facility were not above laboratory reporting limits (EMCON, 1996). The current status of the LUST number is “5R1”, which indicates the file is closed and soil levels meet RBCA Tier 1 requirements.

### **2.9.5 Former Mogul Facility**

The former Mogul property is located at 3030 North 30<sup>th</sup> Avenue, approximately 1,900 feet south-southwest of the VW&R facility (Figure 2-25). A water treatment business was operated under different owners at the site from 1962 to 1995. Willmore Manufacturing, which produces accessories for cars and trucks, purchased the property in 1997 (SCS Engineers [SCS], 1998).

WESTON completed a review of ADEQ’s internal files on previous investigations at the property. Site investigation activities began with a Resource Conservation Recovery Act (RCRA) SI by ADEQ in 1988. This led to several additional investigations that included soil and groundwater sampling and a 1992 ADEQ CERCLA SI. Analyses of soil and groundwater samples indicated that a release of metals and VOCs occurred at the facility (ADEQ, 1993b).

Historical groundwater sampling indicated the presence of TCE, PCE, 1,1-DCE, dibromochloromethane, 1,2-DCA, benzene, and chromium above laboratory MDLs. WESTON added groundwater monitor wells MGL-1, MGL-2, and MGL-3, located on the Mogul property, to the WCP East Grand Avenue WQARF Site groundwater-sampling network during Round 8. VOC concentrations detected in the Mogul wells since sampling for the WCP East Grand Avenue WQARF Site RI began are as follows:

- PCE, 0.3 to 0.7 µg/L
- TCE, 4 to 9 µg/L
- 1,2-DCA, 1 to 26 µg/L
- 1,1-DCE, 0.6 to 1 µg/L
- Benzene, 0.5 to 170 µg/L

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